Claims

1. A method of particle size and concentration measurement comprising the following steps:
    - providing a focused, synthesized, typically non-Gaussian laser beam:
    - causing said beam to interact with said particles;
    - measuring the interaction signal and number of interactions per unit time of said beam with said particles; and
    - using algorithms to map said interaction signals to said particle size and said number of interactions per unit time to said concentration.

2. A method according to claim 1, wherein the particles are fluid borne, airborne, or on a surface.

3. A method according to claim 1, wherein the size of the particles ranges from sub-micron to thousands of microns.

4. A method according to claim 1, wherein the focused, synthesized, non-Gaussian laser beam is a dark beam.

5. A method according to claim 1, wherein the measurements are made in the intensity domain.

6. A method according to claim 1, wherein the measurements are made using the mapping of the interaction pulse width to particle size.

7. A method according to claim 1, wherein the focal properties of the laser beam are changed depending on the size and concentration range of the particles.

8. A method according to claim 1, wherein the non-Gaussian beam is generated by employing a mask over a Gaussian laser beam.

9. A method according to claim 8, wherein the Gaussian beam is spatially modulated.

10. A method according to claim 8, wherein the Gaussian beam is spatially modulated by use of spatial-filter, a set of spatial filters, an electronic spatial light modulator, or a liquid crystal device.

11. A method according to claim 8, wherein the spatial modulation of the Gaussian beam is chosen from the group comprising:

- intensity modulation;
- phase modulation;
- wavelength modulation
- polarization, modulation; and
- combinations of these.

12. A method according to claim 11, wherein the spatial modulation is implemented statically.

13. A method according to claim 11, wherein the spatial modulation is implemented dynamically

14. A method according to claim 1, wherein the non-Gaussian beam is generated by directly modifying the laser cavity or combining the beams from several lasers.

15. A method according to claim 1, wherein the interaction of the focused beam with the particles is accomplished by causing said particles to flow relative to a stationary beam.

16. A method according to claim 1, wherein the interaction of the focused beam with the particles is accomplished by providing a scanning mechanism that provides a linear scanning path for said focused beam.

17. A method according to claim 1, wherein the interaction of the focused beam with the particles is accomplished by providing a scanning mechanism that provides a rotary scanning path for said focus beam.

18. A method according to claim 1, further comprising the use of a detection system to measure radiation scattered at 90 degrees to the beam direction to verify single particle interaction in the focal area or as an additional dark field information.

19. A method according to claim 18, wherein the detection system used to measure radiation scattered at 90 degrees to the beam direction comprises a CCD camera.

20. A method according to claim 18, wherein the detection system used to measure radiation scattered at 90 degrees to the beam direction comprises several detectors.

21. A method according to claim 20, wherein the several detectors are connected in a way selected from the group: addition, differential, and coincidence.

22. A method according to claim 1, wherein a detection system is used to measure radiation back-scattered from the particles.

23. A method according to claim 1, further comprising the use of a detector to measure radiation scattered at 90 degrees to the beam direction to detect smaller particles using dark field TOT measurement.

24. A method according to claim 1, wherein high concentrations of particles are measured by using a reflection, back scatter, mode, collecting the back-scattered interaction energy from the particle.

25. A method according to claim 19, wherein counting interaction signals, of the scanning laser beam, per unit time is used to measure high concentrations of particles.

26. A method according to claim 1, wherein the algorithms to map the interaction signals to the particle size and the number of interactions per unit time to the concentration are explicitly based on said interaction signals.

27. A method according to claim 1, wherein the algorithms to map the interaction signals to the particle size and the

number of interactions per unit time to the concentration are based on an advanced artificial intelligence method.

28. A method according to claim 1, wherein the advanced artificial intelligence method is a Neural Network or support vector method (SVM).

29. A system for particle size and concentration measurement comprising:
    - one or more lasers to provide a Gaussian laser beam;
    - a scanning mechanism;
    - means for converting said Gaussian laser beam into a structured (non- Gaussian) laser beam; and
    - detection means.

30. A system according to claim 29, wherein the means for converting the Gaussian laser beam into a structured (non-Gaussian) laser beam consist of a combination of a spatial filter and a lens.

31. A system according to claim 29 additionally comprising a second detection system to measure the radiation scattered at 90 degrees to the beam direction.

32. A system according to ,claim 29, additionally comprising a beam splitter to divert back-scattered interaction energy from the particle to the detection system.

33. A method according to claim 1, wherein the synthesized, non-Gaussian laser beam is circular.

34. A method according to claim 1, wherein the synthesized, non-Gaussian laser beam is linear.

35. A method according to claim 1, wherein the particle size is determined by differential interference of the light scattered from said particle with the two lobes of a linear synthesized, non-Gaussian laser beam.

36. A method according to claim 1, wherein the particle size is determined by analyzing the polarization of the light scattered from said particle.

37. A method according to claim 1, wherein two or more confocal beams are simultaneously generated, each of said beams having a different wavelength.